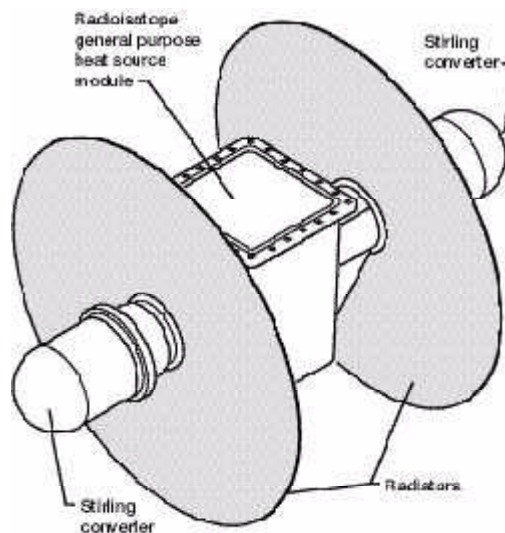


Lightweight Radiators Being Developed for Advanced Stirling Radioisotope Power Systems

The thermodynamic heat-to-electric power conversion efficiency of Stirling systems is 3 to 5 times higher than that of thermoelectric converters. Hence for unmanned deep space probes, Stirling advanced radioisotope power systems (ARPS) could deliver up to 5 times as much power as radioisotope thermoelectric generators for the same amount of radioisotope, or they could require one-third to one-fifth as much isotope inventory for the same power output. However, Stirling power systems reject unconverted heat at much lower temperatures than radioisotope thermoelectric generators. Normally, this requires larger and heavier heat-rejection subsystems because of the greater radiator areas, which are proportional to the first power of the heat rejected and the fourth power of the absolute heat-rejection temperature, as specified by the Stefan-Boltzmann radiation heat transfer law. The development of directly coupled disk radiators using very high conductivity encapsulated thermopyrolytic graphite materials represents a significant advance in Stirling ARPS space heat-rejection subsystem technology. A conceptual Stirling ARPS with two engines coupled to a radioisotope general-purpose heat source (GPHS) is shown in the illustration.



Stirling ARPS with high-conductivity disk radiators.

The direct mounting of the disk on the engine "cold" end will practically eliminate heat transport temperature drop. The high thermal conductivity (over 3 times that of copper) will result in much lower temperature drops between the inner diameter and the outer rim of the disk radiators. Consequently, the radiators will operate at higher average temperatures and thus require smaller surface areas. At the same time, the low density of the material will lead to lower weight. Since the radiators are impervious to micrometeoroid impacts, their survivability and reliability over multiyear deep space

missions will be superior to those of radiator systems that use heat-transfer fluids.

Fabrication of thermopyrolytic graphite disk radiators that could be used on a Stirling ARPS will be undertaken under a Phase II SBIR contract with k Technologies Corporation. A design code developed in house at the NASA Glenn Research Center, GPHRAD, will aid in the radiator designs. The relative simplicity of the design, without liquid transport lines, or heat pipes, should also lead to low fabrication and assembly costs, once the proper manufacturing procedures have been worked out during this contract.

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